

## USES OF POTATO STARCH AND POTATO FLOUR IN THE UNITED STATES<sup>1</sup>

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Potato starch is one of the purest of all commercial starches. It is produced by grinding potatoes to a fine pulp, screening the diluted pulp to remove the comminuted skins and fibrous material, washing the impure starch to remove the soluble substances, dewatering the purified starch suspension, and drying to approximately 17 per cent moisture content. High quality commercial potato starch contains about 99 per cent pure starch on the dry basis, with only small amounts of mineral substances, fiber, and soluble organic compounds present.

Conventional potato flour consists of the whole potato, except the peel, reduced to dry form. In its production, potatoes are peeled, cooked, mashed, dried on drum driers, and the resultant flake is ground. The average composition of 100 samples of potato flour made from the 1948 crop was as follows in percentages on the dry basis (6): Carbohydrate 78; ash (inorganic material left after ignition of sample) 4.40; protein 10.21; crude fiber 1.8; crude fat 0.3. The average flour contained 8.1 per cent moisture.

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#### PRODUCTION DATA

There are 21 potato starch plants in Maine, having a total capacity for producing about 90 million pounds of starch in a 200-day operating season (from Oct. 1 to June 1). During the past campaign, the availability of potatoes and brisk demand for starch kept the factories operating at capacity. As a result, a record quantity of 14 million bushels of potatoes was processed in Maine's plants to make 88 million pounds of starch. Six plants in Idaho produced 64 million pounds of potato starch last season. Therefore, the entire U. S. industry turned out 152 million pounds of starch during 1950-1951. This amount was much greater than the previous high total of 89 million pounds produced during the 1946-1947 season.

Potato flour is produced in four plants in Idaho, one in Minnesota, and one in North Dakota. Although the total capacity of this industry on a 24-hour day basis for 200 days a year is nearly 40 million pounds, production amounts to approximately 15-20 million pounds annually.

#### USES OF POTATO STARCH

According to data supplied by the Maine Institute of Potato Starch Manufacturers (2), starch made in that state is distributed among its various outlets in approximately the following proportions in percentages: textiles 42; paper 28; food uses, including thickeners, 14; adhesives 10; and miscellaneous 6.

Cornstarch is by far the most widely used starch in the United States. For many years, potato starch was used only in specific applications in which its unique properties make it preferable, since corn and tapioca starches were cheaper. For the past two years, however, potato starch and cornstarch have sold at approximately 5½ to 6 cents a pound delivered to Eastern cities; at times, potato starch has even been cheaper. This favorable price situation, coupled with the industry's successful effort to assure a continuous supply of high quality material, has increased the general use of potato starch.

##### *Textiles:*

More potato starch is used in the sizing of cotton, worsted, and spun rayon warps in the textile industry than in any other single application. In warp sizing, parallel threads that run lengthwise in the loom dip into a bath of hot starch paste formulation; the sized thread passes over heated drums to effect drying after leaving the bath. The function of warp sizing is to bind tightly the loose fibers to the surface of the thread, and thereby strengthen and protect the warp from abrasion during weaving. "High count" warps, containing many individual fibers spun together, are difficult to size because of small interstitial space between the fibers. Potato starch is preferred over cereal starches in warp sizing because its paste penetrates farther before gelling. Deeper penetration of the starch results in formation

of a film that adheres well to the warp and consequently gives it more strength and resistance to abrasion. It is well known that potato starch films have a high degree of toughness and flexibility relative to other starches. This permits potato starch sized warps to be woven at lower humidity than those sized with cornstarch.

The smooth, clear pastes obtained with potato starch also have other advantages in warp sizing. Cereal starch pastes frequently contain large aggregates of gelled material, which stick to the warp and subsequently get caught in the loom to cause thread breakage. Potato starch sized warps not only have a smoother finish, but are also easier to de-size after the size has served its purpose. The lesser tendency of potato starch pastes, in comparison with cereal starch pastes, to "set back" or retrograde to a gel is of advantage following shutdowns. It is also claimed that less tallow is required in potato starch sizes to minimize sticking of warp to drying drums than with other common starches. Potato starch is said to be superior for sizing warps that have been previously dyed in that it gives a brighter color.

The finishing of cotton sewing thread is similar to warp sizing. The thread is immersed in a finishing bath and then passed over brushes to provide a smooth finish. Many manufacturers of cotton thread, like textile manufacturers in their warp sizing, use potato starch exclusively.

Potato starch is not outstanding in its ability to bring out color intensity of vat dyes when used as a thickener for textile printing pastes, but it possesses superior properties as a finishing agent. Cloth finished with potato starch has a better "feel" and smoother surface than obtained with cereal starches.

#### *Paper:*

Expanded use in the paper industry has been the outstanding potato starch development during the past few years. Starch is used for four purposes in paper manufacture: (1) Beater sizing in which the cellulosic fibers are cemented together preparatory to sheet formation; (2) tub sizing, in which the preformed sheet is passed through a dilute size solution; (3) calender sizing, in which a smooth finish is imparted; and (4) surface coating, which is an optional step in finishing high-grade papers. Starches and dextrans are also used in combining and sealing paperboard in the fabrication of folding, corrugated, and laminated solid-fiber boxes.

Cold-water soluble potato starch is outstanding in its performance in beater sizing. It is preferred to the corresponding products from other starches for this purpose because its paste possesses great stringiness and cohesive strength. Furthermore, these properties are said to be affected but relatively little on addition of alum. Alum is regularly used in paper

manufacture and its acidic character is detrimental to the properties of most starch pastes.

In general, potato starch, when used in the optimum manner, gives much better retention of fiber fines and fillers and better sheet strength properties, *e.g.*, bursting strength, folding endurance, tensile strength, erasure, and surface picking resistance than obtained with cereal starches (3). Houtz (1) found that hand-made sheets sized with potato starch gave significantly higher values in folding and bursting strengths and slightly higher in breaking strength than those sized with tapioca, corn, and sweet potato starches.

#### *Food Uses, Including Thickeners:*

Much of the potato starch utilized in the food industry is used in bakers' specialty items, such as Swedish and German style breads, in crackers, and in matzoth. It is also used as a thickener in soups and in gravies. Potato starch has been pelleted successfully to make puddings similar to those ordinarily made from tapioca starch.

Starch is used in the confectionery industry for the following purposes: (1) As a medium for molding cast candies such as jelly beans, "orange slices," gum drops, *etc.*, (2) as a bodying agent and to impart smoothness and stability to caramels and marshmallows; (3) as a thickening agent in synthetic jellies; (4) as a dusting agent, perhaps mixed with powdered sugar, for candy gums, chewing gum, *etc.* Thin-boiling rather than thick-boiling starch is ordinarily used as an ingredient in candy manufacture. Starch constitutes about 10-12 per cent of the total weight of dry ingredients in candy gums.

Glucose sirup produced by the hydrolysis of starch is widely used in candies, beverages, chewing gum, ice cream, and confections in general. Very little potato glucose sirup is being produced at present; during World War II, however, when corn, beet, and cane sirups were under allocation, several plants made potato sirup.

#### *Adhesives:*

Most of the potato starch used in adhesives is in the dextrinized form. Dextrins are produced by roasting starch in the presence of an acid. It has long been recognized that films of dextrins made from root and tuber starches such as tapioca, sweet potato, and potato, have greater flexibility and resistance to checking than dextrins of cereal starches. Potato dextrins are used in many applications in which their specific properties make them desirable; for example, as a binder in sand paper, abrasive cloth, bookbinding, and rug sizing, each of which requires a dextrin of high paste tackiness and of flexible residual film. Potato dextrin films are also outstanding for their ease in remoistening; this property is

desired in mucilages used for gumming stamps, labels, envelopes, paper tape, etc.

#### *Miscellaneous Uses:*

There are a number of miscellaneous uses of starch that cannot be classified under the general categories discussed above. Examples of these miscellaneous uses include utilization of starch as: (1) Hygroscopic addition agent to baking powder; (2) fermentation raw material; (3) binder for tablets; (4) binder and extender for sausages; (5) builder for soap; (6) separator in dry cell batteries; (7) raw material for nitrostarch manufacture; (8) consistency stabilizer for oil well drilling "muds"; (9) attractant in insecticidal mixtures; (10) boiler feed water treating agent; and (11) clarifying agent for waters used in mining operations. The miscellaneous uses of potato starch probably include some of these listed. Manufacturers and distributors of potato starch, for business reasons, hold as confidential information concerning some of the lesser uses of their product.

#### USES OF POTATO FLOUR

It is estimated that 90 per cent of the 15-20 million pounds of potato flour used each year in the United States is consumed by the baking industry. The use of potato flour has grown steadily, if not rapidly, ever since its introduction during the first World War. Attempts to introduce the flour into outlets such as meat products, macaroni, and prepared soups, however, have not been particularly encouraging.

Most of the carbohydrate in potato flour is starch, all of which is gelatinized and in rather soluble form. Much of the nitrogenous material is also soluble. Valuable mineral substances, particularly compounds of potassium, magnesium, and phosphorus, which are essential in stimulating yeast growth, are present in amounts adequate for vigorous fermentation. Gases produced by an active fermentation give the desired porosity and texture in bread. Less volatile substances produced in the fermentation remain in the final loaf and contribute to its flavor and aroma.

Two levels of potato flour are used in bread. The lower level, 2 to 3 per cent potato flour (based on the wheat flour) is used in ordinary white bread. A higher level of potato flour, about 6 per cent, is used in "potato bread."

Baking laboratories have found that bread made with 2 and 3 per cent potato flour toasts better than corresponding controls. They have also found that addition of potato flour (up to 4 per cent) increases the absorption of water in direct proportion to the amount added. This is probably the explanation for the commonly mentioned observation that potato bread is softer and keeps fresh longer than ordinary bread. The

reader is referred to a recent article for further details on the use of potato flour in baking (5).

Efforts to develop uses of potato flour in non-food industries have not been encouraging because competitive products have been cheaper. Nevertheless, uncooked potato flour produced from unpeeled potatoes under less expensive methods than the conventional food grade flour from cooked, peeled potatoes may eventually find industrial applications, *e.g.*, as a nutrient and primary raw material in industrial fermentations. To cite one example of non-food use of potato flour, up to 10,000 pounds of this product have been used per year as an attractant in insecticides (4).

#### FUTURE OUTLOOK

Since potato starch is desirable for many applications in which it has not previously been used because of price considerations, extension of its uses could possibly take place. Greater use in the paper industry in New England and the Northwest offers perhaps the best opportunity for expansion. This depends on whether manufacturers of potato starch can continue to match their cornstarch competitors by insuring quality, constant supply, and some price stability.

There is reason to believe that further expansion will occur in the use of potato flour in the baking industry. Although the uptrend is slower than with potato starch, the movement is unmistakable. The increasing popularity of prepared mixes for yeast-raised doughnuts is one of the most important developments in the potato flour industry during the past 15 years. Extension of the use of potato flour in other prepared dry mixes could result in considerable expansion in the demand for this potato product.

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